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A METHOD FOR THE APPLICATION OF CHANGE-IN-GRADE FACTORS TO INDIVIDUAL LOGS--AN IBM 650 PROGRAM

By Carl A. Newport

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A METHOD FOR THE APPLICATION OF CHANGE-IN-GRADE FACTORS TO INDIVIDUAL LOGS--AN IBM 650 PROGRAM

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Timber appraisers and timber quality researchers collect data on lumber grade recovery for each individual log as a basis for meeting their several objectives. Each mill study presents them with many difficulties in data collection and computation. A great deal of manpower and coordination is needed to keep track of lumber from each log throughout the processing--from log pond, through headsaw, edgers, resaw, trim saw, over the green chain, through the drying and surfacing facilities, and out to the shipping sheds. The most difficult stage is during the drying and surfacing processes.

This report presents a method which can save time by eliminating board identification beyond the green chain, increase accuracy in field data collection during the drying and surfacing processes, and greatly reduce office computations. The method can also be used to quickly apply current information on prices and market conditions to previously collected study data. This latter advantage is particularly important to timber appraisers.

OBJECTIVE OF THE METHOD

The application of this method requires that individual boards be accounted for only through the rough green stage of processing. What appraisers and researchers usually want, however, is information for each log on:

1. The volume of surfaced dry lumber recovered in each lumber grade.

2. The total volume of surfaced dry lumber recovered.

3. The value of the log under any given surfaced dry lumber grade price situation.

The objective of the method, then, is to bridge the gap between the rough green lumber grade volumes recorded for each log and the three variables. This report presents the method and briefly explains an IBM 650 program which effectively handles the computations involved.

ARITHMETIC AND SYMBOLOGY OF THE METHOD

Besides the basic information on rough green lumber grade recovery for each log, application of this method requires a table of conversion factors to indicate change in grade from green to surfaced dry and a listing of the prices of the various surfaced dry lumber grades.

The conversion factors should be patterned after the example given in table 1. They may be available from previous studies or may be specially developed.

Each one of the conversion factors is referred to with the symbol K_{ij}. "K_{ij}" is defined as being the decimal portion of the volume of lumber in the jth green grade which ends up in the ith surfaced dry grade. For example, $K_{1,1}$ indicates that .355 times the volume in the first green lumber grade (B and better) ends up in the first surfaced dry lumber grade (B and better). $K_{2,10}$ indicates that .001 times the volume in green grade 2 (C select) ends up after surfacing and drying in surfaced dry grade 10 (3 common).

The conversion factors for a study can be determined from drying and surfacing all or a sample of the study lumber from the mill. If a sample is used the size depends upon the amount of change in grade to be expected. This in turn depends upon the rough green grader, the physical drying and surfacing equipment, and the character of the lumber. To date the effect of these factors has not been sufficiently measured to facilitate sample size calculations. However, if the green grader is fully certified by a manufacturing association and the drying and surfacing is properly carried out, a sample of at least 2,000 board feet in each rough green grade should be sufficient.

The source of the prices for the various lumber grades depends upon the log value desired. In some Forest Service appraisals the prices used are collected from sales data in the region. A lumber company might use its own price lists.

One restriction is placed on the prices. They must correspond to the final lumber grade condition in the conversion table, that is, surfaced dry. The prices are referred to as P_i. "P_i" would be the dollars per board foot price of surfaced dry lumber grade 1, P_2 of grade 2, etc.

The calculations for an individual log in this method are according to the following procedure.

1. The volume of each green grade is multiplied by each K factor whose i = 1 and whose j subscript corresponds. These products are added and recorded. Then the volume of lumber in each green grade is multiplied by each K factor which has i = 2 and whose j subscript corresponds, similarly added and recorded, and so forth.

Table 1.--Example of table of conversion factors

Original green grade	j	Decimal portion of lumber in final surfaced dry grade													Total portion
		B & better	C Select	D Select	Moulding	No. 3 Clear	1 Shop	2 Shop	3 Shop	1 & 2 Common	3 Common	4 Common	5 Common		
i		1	2	3	4	5	6	7	8	9	10	11	12	13	14	
B & Better	1	($k_{1,1}$) .355	($k_{2,1}$) .389	($k_{3,1}$) .107	($k_{4,1}$) .047	($k_{5,1}$) --	($k_{6,1}$) .002	($k_{7,1}$) --	($k_{8,1}$) .003	($k_{9,1}$) --	($k_{10,1}$) --	($k_{11,1}$) --	($k_{12,1}$) --	($k_{13,1}$) --	($k_{14,1}$) --	.903[1/]
C Select	2	($k_{1,2}$) .045	($k_{2,2}$) .489	($k_{3,2}$) .262	.112	--	.002	--	--	--	.001	.004	--	--	--	.915
D Select	3	($k_{1,3}$) .001	.069	.520	.251	.008	.011	.019	.012	.005	.009	.012	.001	--	--	.918
Moulding	4	($k_{1,4}$) .003	.003	.048	.690	.020	.039	.085	.043	--	.008	.004	.002	--	--	.945
3 Clear	5	--	.001	.003	.014	.611	.272	.037	.003	--	.009	.009	--	--	--	.959
1 Shop	6	--	.001	.004	.007	.057	.536	.297	.012	.001	.006	.023	.009	--	--	.953
2 Shop	7	--	.001	.003	.002	.006	.068	.588	.220	--	.003	.019	.015	--	--	.925
3 Shop	8	--	.002	.007	.003	--	.005	.048	.679	--	.155	.001	.040	--	--	.940
1&2 Common	9	--	--	.006	.001	--	--	--	--	.715	.228	.027	.002	--	--	.979
3 Common	10	--	--	.003	--	--	--	--	--	.178	.602	.188	.009	--	--	.980
4 Common	11	--	--	.007	,005	--	--	--	.007	.009	.158	.628	.133	--	--	.947
5 Common	12	--	--	.001	.002	--	--	--	.002	.002	.021	.276	($k_{12,12}$) .608	--	--	.912
	13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

1/ This column reflects the reduction in total volume from green to dry grade. For example, .903 indicates a loss of 9.7 percent.

2. The total surfaced dry lumber recovery for each log is obtained by adding all of the individual surfaced dry grade recovery volumes obtained in step 1.

3. The dollar value of the log is obtained by multiplying each surfaced dry lumber grade volume from step 2 by the appropriate price. These products are then totalled to give a total value for the log.

THE METHOD APPLIED ON IBM 650

The IBM 650 and other electronic computers are well adapted to carrying out this procedure. The method has been programmed for the IBM 650 and thoroughly tested at the Pacific Southwest Forest and Range Experiment Station. You can obtain the program cards and operating instructions by writing to the Director, P. O. Box 245, Pacific Southwest Forest and Range Experiment Station, Berkeley 1, California.

Following is a brief explanation of the program and the input card preparation. This will illustrate the ease with which the data can be prepared.

PURPOSE OF PROGRAM IN SYMBOLS

From input consisting of conversion factors, K, log data, X, and prices, P, the following calculations are performed:

$$Y_i = \sum_{j=1}^{14} K_{ij} X_j \qquad j = 1,2,\cdots 14$$

$$Z = \sum_{i=1}^{14} Y_i$$

$$C = \sum_{i=1}^{14} P_i Y_i$$

Y_i, Z, C as defined below are punched out with indicative information from the X_i input card. (See appendix for sample output card.)

PROGRAM LIMITATIONS

This program is designed to handle a maximum of 14 green lumber grade classifications and 14 surfaced dry lumber grade classifications. The symbols are identified and limited as follows:

Symbol		Data	Decimal Position
X_j	=	Green lumber grade volume, bd. ft. (j = 1 to 14)	(XXX.X)
Y^j	=	Dry lumber grade volume, bd. ft. (i = 1 to 14)	(XXX.X)
Z^i	=	Total dry lumber volume, bd. ft.	(XXXX.X)
K_{ij}	=	Decimal conversion factor (i = 1 to 14, j = 1 to 14)	(.XXX)
P_i	=	Value per bd. ft., surfaced dry lumber in dollars	(.XXXXX)
C^i	=	Value of log, surfaced dry lumber in dollars	(XXXXX.XX)

INPUT CARD PREPARATION

1. Rough green lumber grade and other log data cards.

No blank columns are permissible in these X data cards. Zeros may be used when a field is otherwise blank. (Appendix A is sample description of the log data card.)

2. The conversion factor cards.

Conversion factors, K, are identified by four digits. The first two digits equal i, the number of the final or surfaced lumber grade. The last two digits equal j, the number of the initial or green lumber grade. The identification of each factor must be punched in columns 5-8 on a load card, (12 punch, column 1) with the element punched in word 2 and justified to the right. The factors are entered one-per-card. No card is needed when a factor is zero. (See Appendix C.)

3. The price cards.

Lumber prices, P, are identified by four digits. The first two digits are constant zeros. The last two digits are 81 to 94 corresponding to prices 1 to 14 for the surfaced dry lumber grades (i = 1 to 14). This identification of each price must be punched in columns 6-8 on a load card, (12 punch, column 1) with the price punched in word 2 and justified to the right. The prices are entered one-per-card. No card is needed when a price is zero. (See Appendix D.)

4. Note: Since K and P are entered on load cards, a sign punch must be present in the low order position of each field (columns 10, 20). Be sure all 10 columns in each field that is used are punched (use zeros).

OPERATING TIME

This program operates at the rate of 11 seconds per card or 330 cards per hour.

When the value only is computed (see special modifications) the program operates at 2.5 seconds per card or 1,440 cards per hour.

In most applications each card contains all the data for each log. If the same calculations were made on a desk calculator, it would take a minimum of 15 minutes per log. This does not include verification which is done internally on the IBM 650 program.

OPERATING INSTRUCTIONS

1. Place standard 80-80 control panel in 533 unit. (Note: Load hub on Col.1.)

2. Ready punch feed with blank cards.

3. Ready read feed as follows:

   a. Program deck with drum clear card
   b. K and P cards
   c. X data cards

4. Set console as follows:

   a. Storage entry switches: 70 1952 9999
   b. Programmed: Stop
   c. Half cycle: Run
   d. Address switches: Anything
   e. Control: Run
   f. Display: Program register
   g. Overflow: Stop
   h. Error: Stop
   i. Sign switch: Positive (Negative if only value computation is needed. Be sure this is set before program cards enter.)

5. To start 650:

   a. Depress "computer reset" button.
   b. Depress "program start" button.
   c. Depress "start" buttons on 533.

6. Programmed stops

Program Register Display	Cause
0123456789)	Wrong card code or non-load card entering as load card.
9876543210)	

To restart, transfer control to 0177.

SPECIAL MODIFICATIONS POSSIBLE ON THE IBM 650

1. Computing value only.

After the logs from a given study have been analyzed for surfaced dry value, it may be desirable or necessary to recalculate value with different or more current prices but the same surfaced dry recovery. The IBM 650 program has provided for a branching (when sign switch set "negative") that will bypass the grade conversion and calculate value of the logs on the basis of whatever lumber grade distribution appears on the input cards. In other words the output from a first run of this program can be used as input for a second run which will use a different price list.

2. Special conversion factors.

Under certain circumstances the conversion to be made is from rough green to shipping tally, where shipping tally includes part or all of certain grades being shipped rough green or rough dry. The mathematics of conversion are the same as described here, but the conversion factors must be computed to take into account the fact that not all of any given grade is dried and surfaced. Consider the example in table 1. If 50 percent of B and better is usually marketed in the rough green, then each factor in line one would be multiplied by .50 and .50 would be added to $K_{1,1}$. The new factors in line one would be .678, .194, .054, .023, .001, and .002. This procedure would be applied to each line of the table.

When selling prices are collected each year for timber appraisal, the proportion of the volume of each grade being sold without surfacing and/or drying may change. The conversion factors must be changed when the newer prices are applied. This can be done with no difficulty using this 650 program.

3. More than 14 lumber grades.

The 14 lumber grades provided for in this program are enough for the data from most mill studies. However, when the price list to be used includes grade-items, such as several thicknesses and widths within a lumber grade, more than the 14 fields provided in this program may be necessary. Furthermore, the conversion factors may also vary for thickness and width within lumber grades. Problems like these have been solved with this program by making more than one card for each log. The lumber grade-items must be grouped on input cards, X_j, in such a way that the output cards containing Y_i will not result in more than 14 lumber grade-items. Correct groups can be selected from the table of grade-item conversion factors before preparing the input cards containing X_j, K_{ij}, and P_i.

APPENDIX

A. SAMPLE 650 INPUT CARD, BASIC DATA CARD NUMBER 3 (X_i)

Columns	Field
1	Card number (code 3)
2,3	Study number
4-6	Log number
7,8	Log diameter
9	Log grade
10,11	Log length
12-23	Other log identification
24-27	X_1. Rough volume of B and Better (board foot, 1 decimal)
28-31	X_2. Rough volume of C Select (board foot, 1 decimal)
32-35	X_3. Rough volume of D Select (board foot, 1 decimal)
36-39	X_4. Rough volume of Misc. Selects (board foot, 1 decimal)
40-43	X_5. Rough volume of No. 3 Clear (board foot, 1 decimal)
44-47	X_6. Rough volume of No. 1 Shop (board foot, 1 decimal)
48-51	X_7. Rough volume of No. 2 Shop (board foot, 1 decimal)
52-55	X_8. Rough volume of No. 3 Shop (board foot, 1 decimal)
56-59	X_9. Rough volume of 1 and 2 Common (board foot, 1 decimal)
60-63	X_{10}. Rough volume of 3 Common (board foot, 1 decimal)
64-67	X_{11}. Rough volume of 4 Common (board foot, 1 decimal)
68-71	X_{12}. Rough volume of 5 Common (board foot, 1 decimal)
72-75	X_{13}. Zeros
76-79	X_{14}. Zeros
80	Zero

B. SAMPLE 650 OUTPUT CARD, SURFACED DRY VOLUME AND VALUE CARD NUMBER 6 (Y_i)

Columns	Field
1	Card number (code 6)
2,3	Study number
4-6	Log number
7,8	Log diameter
9	Log grade
10,11	Log length
12-16	Total volume of log, surfaced dry lumber (board foot, 1 decimal
17-23	Value of log, surfaced dry lumber in dollars (2 decimals)
24-27	Y_1. Surfaced dry volume of B and Better (board foot, 1 decima
28-31	Y_2. Surfaced dry volume of C Select (board foot, 1 decimal)
32-35	Y_3. Surfaced dry volume of D Select (board foot, 1 decimal)
36-39	Y_4. Surfaced dry volume of Misc. Selects (board foot, 1 decima
40-43	Y_5. Surfaced dry volume of No. 3 Clear (board foot, 1 decimal
44-47	Y_6. Surfaced dry volume of No. 1 Shop (board foot, 1 decimal)
48-51	Y_7. Surfaced dry volume of No. 2 Shop (board foot, 1 decimal)
52-55	Y_8. Surfaced dry volume of No. 3 Shop (board foot, 1 decimal)

Columns		Field
56-59	Y_9.	Surfaced dry volume of 1 and 2 Common (board foot, 1 dec.)
60-63	Y_{10}.	Surfaced dry volume of 3 Common (board foot, 1 decimal)
64-67	Y_{11}.	Surfaced dry volume of 4 Common (board foot, 1 decimal)
68-71	Y_{12}.	Surfaced dry volume of 5 Common (board foot, 1 decimal)
72-75	Y_{13}	Zeros
76-79	Y_{14}.	Zeros
80		Zero

C. CARD DESCRIPTION--CONVERSION FACTOR FOR IBM 650 INPUT (K_{ij})

Columns	Field
1- 4	Zeros
5- 8	Identification number of K_{ij} (0101 to 1414)
9-17	Zeros
18-20	K_{ij} = volume of green grade j which becomes surfaced dry grade i.(3 decimals)
21-78	Blank
79-80	Study number

(12 Punch in columns 1, 10, 20)

D. CARD DESCRIPTION--LUMBER PRICES FOR IBM 650 INPUT (P_i)

Columns	Field
1- 4	Zeros
5- 8	Identification number for P_i (0081 to 0094)
9-15	Zeros
16-20	P_i = value per board foot, surfaced dry lumber grade i, in dollars (5 decimals)
21-78	Blank
79-80	Study number

(12 Punch in columns 1, 10, 20)

ADDENDUM

Since the publication of Technical Paper 41, the IBM 650 program has been modified. This modification does not affect the input, output, or machine instructions as described. It allows the operator to secure an additional calculation of value per unit of volume expressed as dollars per M ft. b.m.

If the operator desires this calculation of value per M ft. b.m., the operating instruction 4.a., storage entry switches, should be set at 70 1952 8888. Regular output card No. 6 will be followed by output card No. 9 which contains information as follows:

Sample 650 Output Card No. 9 Value per M ft. b.m.

Cols.	Field
1	Card number (code 9)
2,3	Study number
4,5,6	Log number
7,8	Log diameter
9	Log grade
10,11	Log length
12,16	Value per M ft. b.m. ($XXX.XX)
17-80	Zeros